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A Survey for Photometric Variability in Isolated Magnetic White Dwarfs – Measuring their Spin Periods

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Abstract. We present the initial findings of a photometric survey of isolated magnetic white dwarfs (MWDs) carried out with the 1.0m Jacobus Kapteyn Telescope. Of our sample of 30 MWDs, we have observed variability in 17 (57%) over our observed timescales (minutes to years), with a further 11 requiring more data, and two that are non-variable at the 1% level. In total we have discovered possible variability in 15 targets that has not been reported before in the literature, and we have measured the spin period of five objects in our sample to within a few percent. We find no correlation between spin period, mass or temperature, but there may be a weak negative correlation between period and field strength for the short-period targets. We have identified 14 MWDs with low field strengths and low temperatures, which are candidates for having star spots on their surfaces and should be followed up with polarimetry. We have also found that three low-field, high temperature MWDs are unexpectedly variable, with no obvious mechanism to cause this.

1. Introduction

The main cause of variability in white dwarfs is pulsations of the star with period $\sim$100 – 1200 seconds as they pass through three temperature regions along the cooling track, but some have been seen to vary on much longer periods ($P \sim$ hours – days), which is generally linked to the rotational period of the star. Photometric variability in high-field MWDs is caused by the dependence of the continuum opacity on the surface field strength (magnetic dichroism; Ferrario et al. 1997). Photometric variability has also been observed in cool, low-field MWDs (Brinkworth et al. 2004, 2005), which we attributed to star spots on the surfaces of the white dwarfs. Theoretically, low-field, hot MWDs should not display variability as their magnetic field strengths are too low to cause magnetic dichroism, and their atmospheres are too hot for convective star spots to form.

2. Observations and Data Analysis

Our photometric data were taken with the 1.0m JKT telescope over three weeks from August 2002 to May 2003. This enabled us to search for variability on

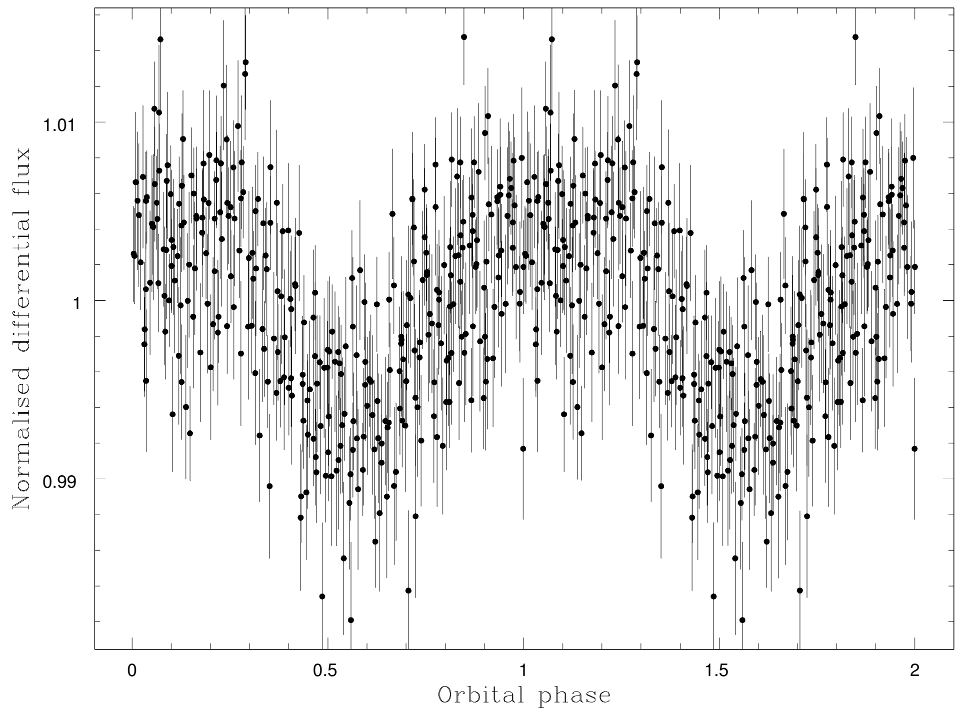

Figure 1. Light curve for PG 1533−057 folded on the best derived spin period of 1.890 ± 0.001 hours

timescales of minutes to a couple of years. We used a 'floating mean' periodogram (e.g., Cumming et al. 1999; Morales-Rueda et al. 2003) to search for periodicity in the differential light curves for each target. We observed strong, periodic variability in five targets (G 111−49, HE 1211−1707, PG 1015+015, PG 1031+234 and PG 1533−057) and strong variability in a further 12 for which we did not have enough data to pin down the period. The folded light curve for one of our periodic targets, PG 1533−057, is shown in Figure 1. The updated spin distribution for MWDs is shown in Figure 2. Table 1 gives the updated periods for the five strongly periodic MWDs in our sample.

Table 1. Period measurements for the five targets with strong, periodic variability

Target	Period from literature	New period
G 111−49	–	6.68 ± 0.03 hours
HE 1211−1707	∼2 hours	1.77 ± 0.43 hours
PG 1015+015	98.7 mins	105 ± 13 mins
PG 1031+234	3.4 hours	3.53 ± 0.05 hours
PG 1533−057	∼ 1 day	1.890 ± 0.001 hours

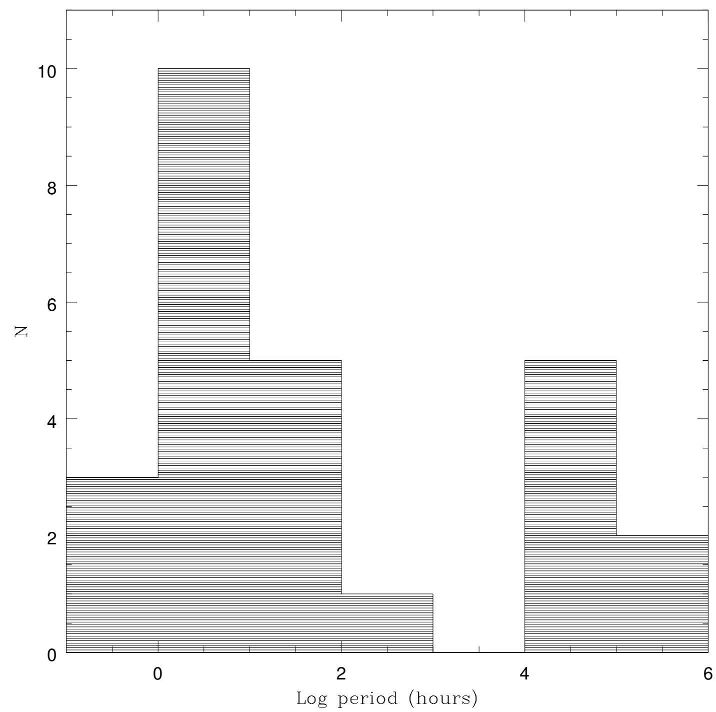

Figure 2. Updated spin period distribution for isolated MWDs. The apparent bimodal distribution is a partly artificial effect as the sources seen to vary on timescales > 1 week have been grouped into a single class with a period of 5 years. The distribution at short periods is real. We expect the peak at $4 < \log(P) < 5$ to smooth out as we determine more accurate periods from our upcoming Liverpool Telescope data.

3. Conclusions

Over half of our sample of isolated magnetic white dwarfs display photometric variability, 15 of which have not been reported variable in the literature before. We have found no correlation between spin period and age, mass or temperature, but there may be a weak negative correlation with magnetic field strength for the short-period systems (see Fig. 3). We have identified 14 targets with low field strength and low temperature, which are candidates for having star spots on their surfaces, and we have also found three low-field, high-temperature MWDs that are unexpectedly variable. Our upcoming data from the Liverpool Telescope will enable us to investigate whether the apparent bimodal distribution of spin periods seen in Figure 2 is real or merely a selection effect.

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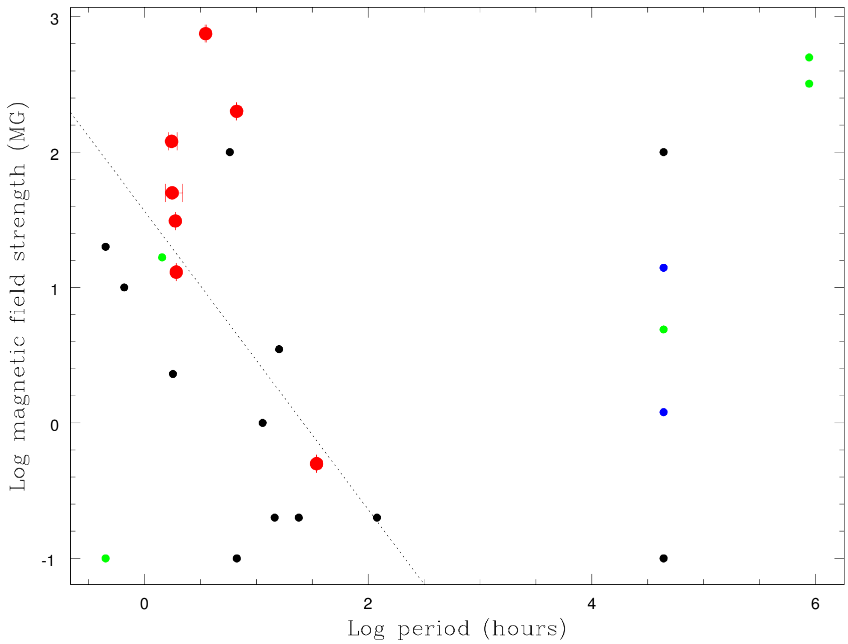

Figure 3. Log field strength vs. log period. Points with error bars have a well-defined period. The dotted line is a fit through the short-period sources.

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